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## Complaint-severity and cervical spine problems successfully classified patients with shoulder complaints

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### Abstract

**Objective:** To construct a classification of patients with shoulder complaints based on their physical examination. To investigate (1) the interobserver reliability, (2) to what extent the setting in which the patients were recruited, and demographic and clinical characteristics are related to the classification.

**Study Design and Setting:** Data from 132 patients with shoulder complaints recruited in various health care settings in The Netherlands were examined. Two observers independently performed a physical examination of the cervical spine and shoulder joint. A nonmetric multidimensional scaling procedure was performed for each observer separately. The interobserver reliability of both observers was computed. Differences between setting, demographic and clinical characteristics, and the resulting dimensions were investigated.

**Results:** For both observers two dimensions (severity of complaints of the shoulder joint, and severity of problems of the cervical spine) were sufficient to classify all patients. Agreement between the two observers was good ( $r = 0.84$ ) to moderate ( $r = 0.69$ ). Patients with neck pain in history taking showed higher scores on both dimensions.

**Conclusion:** Despite moderate interobserver agreement for each variable from physical examination found in previous studies, observers agree on the scores of the patients on the relevant dimensions. Given the limited number of effective treatments available to the general practitioner, a more sophisticated classification system seems unnecessary. © 2004 Elsevier Inc. All rights reserved.

**Keywords:** Shoulder complaints; Diagnosis; Classification; Observer reliability; Multidimensional scaling; Family practice

### 1. Introduction

General practitioners confronted with patients with shoulder complaints are faced with a number of problems. The choice of treatment may be a difficult one considering the lack of clear results of intervention studies [1]. Furthermore, differential diagnosis of shoulder disorders is experienced to be difficult because of the various extrinsic and intrinsic conditions that may underlie shoulder complaints [2]. The lack of consensus on the appropriate diagnostic criteria as well as the fact that several diagnostic classifications have been proposed complicates diagnosis [3–8]. The Dutch College of General Practitioners developed their first guidelines for the diagnosis and management of shoulder complaints in 1990. These guidelines were largely based on the concepts of Cyriax [6,7]. According to Cyriax the anatomic site of

the lesion can be identified from the specific combination of signs, symptoms, and restriction of movements. The major problem in classifying shoulder complaints is that there are no external criteria from which the validity of the classification, in the sense of identifying the site of the lesion(s), can be derived; there is no “gold standard.” A way to overcome this problem is to resort to empiric classification methods. Two studies that tried to reproduce the classification of Cyriax using hierarchical cluster analysis failed to demonstrate the validity of his classification. de Jongh [9] found seven groups of patients using hierarchic cluster analysis. Winters et al. [10] could only reproduce three groups using the same method. Groenier [11] showed by using nonmetric multidimensional scaling that the three groups of patients found by Winters et al. [10] could be ordered along a single dimension, which merely reflected the “severity” of the shoulder complaints.

In 1999, The Dutch College of General Practitioners revised their guidelines in favor of a much simpler diagnostic

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classification [12]. However, since this change in protocol was based on the results of a limited number of studies the question of classification of shoulder disorders is still open for debate.

Another problem that complicates the classification of shoulder complaints is the lack of agreement between observers. A number of studies conducted over the last 10 years have cast doubt on the interobserver reliability with regard to the diagnostic classification of shoulder problems [13–15]. Also, several studies report widely varying interrater reliabilities in measuring the range of motion of the shoulder [16–19]. The study of de Winter [20] is, to our knowledge, the only one in which the interobserver agreement on symptoms, signs of the physical examination of the shoulder joint among a large group of patients, as well as agreement on diagnostic categories in general practice is reported. The kappa values she found ranged between 0.40 and 0.60. Although only very moderate kappa's are reported for the individual signs and symptoms and interobserver agreement on *a priori* categories of diagnosis (Capsular syndrome, Acute bursitis, Acromioclavicular syndrome, Subacromial syndrome, Mixed picture, and a Rest group) is low, the possibility remains that combinations of the various signs and symptoms from the physical examination may lead to an empirical classification on which interobserver reliability is higher.

In the present study we will:

1. Construct an empirical classification of patients with shoulder complaints analyzing the results on symptoms and signs from the physical examination.
2. Investigate the interobserver reliability with respect to this classification.
3. Investigate to what extent the setting in which the patients were recruited (general practice, orthopedic practice, clinic for rheumatology, and rehabilitation) and demographic and clinical characteristics are related to the empirical classification in an effort to aid in the interpretation of the classification.

## 2. Methods

### 2.1. Patients

From the study of de Winter, in which 201 consecutive patients with shoulder complaints from general practice, orthopedic practice, and a clinic for rheumatology and rehabilitation were included, 132 patients had complete data on all variables (for each variable there were only a few missing data, but “listwise” this amounts to the 69 missing cases because of the large number of variables). Details concerning the inclusion of patients and the diagnostic procedure can be found in de Winter et al. [15]. All patients were between 18 and 75 years of age. Patients with shoulder problems due to neurologic, vascular, or internal disorders, systemic rheu-

matic diseases, fractures, or dislocations were excluded. Although the emphasis of the study was on intrinsic shoulder problems, patients with shoulder complaints that might be due to neck disorders, also participated in the study.

### 2.2. Diagnostic procedure

Two examiners (Obs. A and Obs. B) performed the diagnostic procedure that consisted of standardized history taking and physical examination. Both examiners independently performed the physical examination, while the history taking was performed by one of the observers. The sequence of the examiners was randomly assigned.

### 2.3. Variables used in the construction of the classification

- The total score on the Shoulder Disability Questionnaire, a 16-item pain-related disability questionnaire, measuring the degree of disability a patient experiences during daily activities [21,22].
- Evaluation of the presence or absence of restricted range of motion of the cervical spine by assessing the active flexion, extension, right and left rotation, and right and left lateroflexion.
- The presence or absence of pain experienced during each active movement of the cervical spine.
- The degree of restriction of the range of active motion of the affected shoulder compared with that of the nonaffected shoulder. Recorded were the ROM for elevation of the shoulder girdle and abduction.
- The degree of restriction of the range of passive motion of the affected shoulder compared with that of the nonaffected shoulder. Recorded were the ROM for abduction, glenohumeral abduction, internal rotation, external rotation, and horizontal adduction.
- The degree of pain (none, mild, severe) was recorded for each movement (active or passive) of the shoulder joint.
- The presence or absence of a painful arc.
- The presence or absence of a deviation from the normal scapulohumeral rhythm.

### 2.4. Demographic and clinical characteristics

- Sex
- Age
- Setting in which the patients were recruited
- Duration of shoulder complaints.
- Presence or absence of shoulder complaints on both sides.
- Dominant or nondominant shoulder affected.
- Presence or absence of earlier episodes of shoulder pain.
- Presence or absence of neck pain.

- Severity of pain during the day assessed by patients on a Visual Analog Scale.
- Severity of pain at night assessed by patients on a Visual Analog Scale.

## 2.5. Data analysis

### 2.5.1. Construction of a classification

Every patient in the study is characterized by a pattern of scores on the variables used for the construction of the classification. The differences in the patterns are considered to express the dissimilarity between the patients. For each pair of patients the degree of dissimilarity of their patterns can be computed by the square of the Euclidian distance between the patterns [23]. Thus, a matrix of pair-wise dissimilarities is formed that can be further analyzed. The dissimilarities between patients were calculated from all variables for each observer separately. All variables were standardized on a mean of zero and a standard deviation of 1 because they were measured on different scales. A nonmetric multidimensional scaling analysis was performed on the dissimilarities between the patients for each observer separately.

Nonmetric multidimensional scaling refers to a class of statistical techniques that transforms a matrix of dissimilarities between patients into a geometric configuration or map of points in a  $n$ -dimensional space [23,24]. Each patient is represented by a point in this space in such a way that the order of distances between the points reflects the order of the computed dissimilarities as close as possible. This is accomplished by a process of iteration for a given number of dimensions [25]. The difference between the order of the distances and the order of the dissimilarities is expressed in a measure between 0 (perfect agreement between distances and dissimilarities) and 1, called *normalized stress* [26].

The number of relevant dimensions is determined using a procedure suggested by Spence [27].

A configuration with a known dimensionality is generated containing the same number of points as the empirical data. A random component is added to the distances between the points of the configuration. The standard deviation of the random component (relative to the standard deviation of the distances) represents the level of noise in the configuration. Then this simulated configuration is subjected to nonmetric multidimensional scaling in a number of dimensions from one to five. The resulting stress values are plotted against the number of dimensions, forming a stress curve. This process is repeated for various configurations and various levels of noise. By comparing the stress curve of the empirical data with the curves of the simulated data one can find the optimal number of dimensions. The simulated curve that most closely matches the empirical curve corresponds with the optimal configuration.

The interpretation of the dimensions that are found can be inferred from the relationship between the original variables and the resulting dimensions by correlating the scores on the dimensions (derived from the projections of the

points in the space) with those on the variables in the analysis. Also, the relationship between the scores on the dimensions and demographic and clinical characteristics not used in constructing the classification may be helpful in the interpretation of the dimensions.

### 2.5.2. Interobserver reliability

The interobserver reliability will be investigated by correlating the scores from the patients on each dimension for the first observer with the scores of the patients on the corresponding dimension for the second observer, expressed as a Pearson correlation coefficient.

### 2.5.3. Relationship between classification and setting, demographic, and clinical characteristics

The relationship between the resulting dimensions, setting, demographic, and clinical characteristics will be analyzed by means of the Fisher's Exact test for categorical variables, the Mann-Whitney and Kruskal Wallis tests for the relationship between categorical and numerical variables, and Spearman correlation coefficients for the relationship between numerical variables.

A difference is considered statistically significant when the  $P$ -value is lower than 5%.

## 3. Results

### 3.1. History taking

The main demographic and clinical characteristics are presented in Table 1.

Patients included from general practice were, on average, a few years younger, and the duration of the complaints was shorter for them. Patients from the clinic for rheumatology and rehabilitation have a higher frequency of problems with both shoulders, while more patients with problems of the dominant shoulder were included from the orthopedic clinic. Patients from the orthopedic clinic also reported less pain during the day and at night compared to the other two groups.

### 3.2. Multidimensional scaling

Fig. 1 shows the stress curves resulting from the multidimensional scaling analysis.

The observed stress curves are very much the same for both observers. This indicates that both observers use the same classification for patients with shoulder complaints. From the comparison of the curves of both observers with those from the simulations one can conclude that a two-dimensional configuration best fits the empirical data.

The observed normalized stress for the two-dimensional configuration is 0.041 for observer A and 0.048 for observer B.

The Pearson correlation coefficients of the symptoms and signs from the physical examination of the cervical spine

Table 1  
Demographic and clinical characteristics of patients according to setting

	General practice ( <i>n</i> = 50)	Orthopedic practice ( <i>n</i> = 24)	Clinic for rheumatology and rehabilitation ( <i>n</i> = 58)	Total ( <i>n</i> = 132)
Female (%)	72	50	64	64
Mean age in years (SD)	43 (13)	48 (11)	50 (11)	47 (12) <sup>a</sup>
Median duration of current episode in weeks (P25, P75)	18 (9, 53)	53 (25, 55)	43 (22, 55)	37 (13, 55) <sup>b</sup>
Shoulder problems on both sides (%)	18	4	33	22 <sup>c</sup>
Dominant shoulder affected (%)	54	67	29	46 <sup>d</sup>
Previous episode(s) of shoulder pain (%)	38	33	50	42
Presence of neck pain (%)	50	63	71	61
Median severity of pain during the day (P25, P75) <sup>f</sup>	59 (33, 82)	36 (20, 62)	55 (37, 68)	53 (31,73) <sup>e</sup>
Median severity of pain at night (P25, P75) <sup>f</sup>	60 (20, 85)	26 (11, 55)	51 (24,72)	50 (19, 74) <sup>e</sup>

<sup>a</sup> *P* = .003 (one-way analysis of variance).

<sup>b</sup> *P* = .003 (Kruskal-Wallis test).

<sup>c</sup> *P* = .006 (Fisher's Exact test).

<sup>d</sup> *P* = .002 (Fisher's Exact test).

<sup>e</sup> *P* = .02 (Kruskal-Wallis test).

<sup>f</sup> Severity of pain assessed by patients on a VAS (0–100).

and the shoulder joint with the scores on the two dimensions for each observer are presented in Table 2.

Table 2 shows that one of the two dimensions is dominated by items from the physical examination of the shoulder joint, while the other dimension is dominated by items from the examination of the cervical spine. The score on the Shoulder Disability Questionnaire has a substantial correlation with only the first dimension. From Table 2 one can see that patients are classified by the observers according to the severity of their shoulder complaints, from no restrictions in the ROM of the shoulder and/or little pain to severe restrictions and/or pain (dimension 1) and/or the severity of their neck complaints, ranging from little pain and/or restrictions in the ROM of the neck to severe pain/and or restrictions (dimension 2).

### 3.3. Interobserver reliability

The interobserver reliability of the classifications of the observers can be inferred from the correlation coefficients between the two observers. For the first dimension (severity of shoulder complaints) this correlation reaches a value as high as 0.84, while for the second dimension (severity of neck complaints) a lower value of 0.69 was computed.

### 3.4. Setting, demographic, and clinical characteristics

In Fig. 2, the relationship between the scores on the two dimensions and the setting from which the patients were recruited is shown. On the first dimension (severity of shoulder complaints) the scores for the patients recruited from a clinic for rheumatology and rehabilitation are somewhat higher (meaning a higher level of complaints) than those of the other patients, although the differences do not reach statistical significance for observer A (Obs. A:  $p_{\text{dim1}} = 0.10$ ;

Obs. B:  $p_{\text{dim1}} = 0.01$ ). There are no significant differences between the three settings on the second dimension (severity of neck complaints).

Men and women did not differ from each other with respect to the mean scores on both dimensions, nor was there a substantial correlation of the scores with age (Table 3).

Table 3 also shows that the duration of complaints, the severity of the pain experienced by the patients during the day, and the severity of pain at night, both assessed on a Visual Analogue Scale, did not correlate substantially with the scores on the two dimensions for each of the two observers, although some of them were significant beyond the 5% level. The percentage of patients with shoulder complaints in both shoulders was substantially lower for patients recruited from the orthopedic practice (see Table 1), except for higher scores on the second dimension (severity of neck complaints) for observer A (*P* = 0.02); however, the scores of the patients with complaints in both shoulders on the two dimensions were not significantly different from those with complaints in only one shoulder.

Patients with their dominant shoulder affected did not differ significantly from those who had their other shoulder affected with respect to the scores on both dimensions nor did patients who had experienced earlier shoulder problems differ from those without earlier shoulder complaints with respect to their scores on either of the two dimensions.

The difference in scores on both dimensions between patients that report neck pain and those that do not report neck pain in history taking is shown in Fig. 3. As expected there is a highly significant difference between the two groups of patients on the dimension of severity of neck complaints (*P* < .005). However, there is also a significant difference between the groups on the dimension of severity of shoulder complaints (*P* < .005).



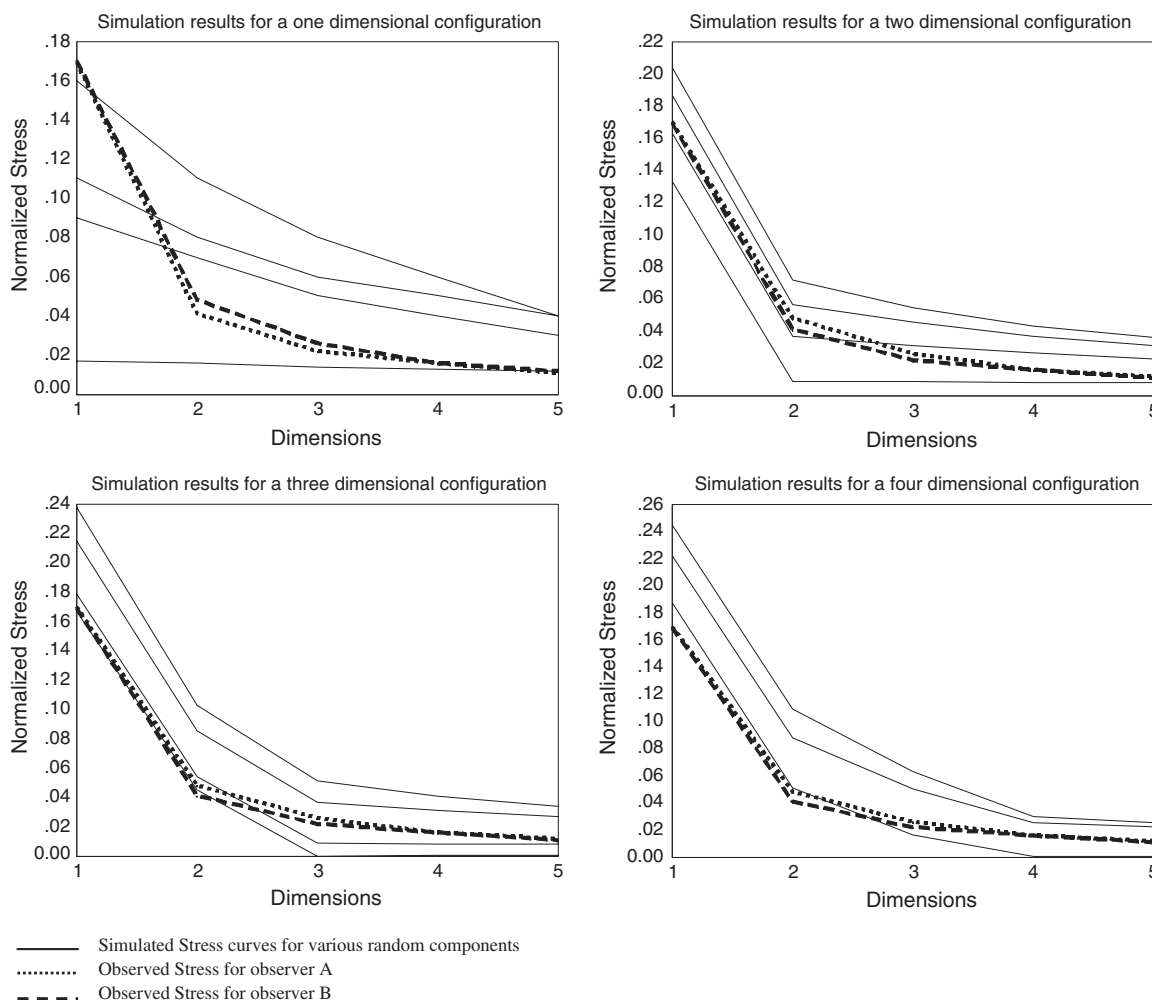


Fig. 1. Stress curves for observers A and B in one to five dimensions compared to four simulated configurations.

#### 4. Discussion

This study confirms the findings of previous studies [9–11] that from the pattern of restrictions in the range of motions of the shoulder and the neck and the severity of pain experienced by patients performing these motions no conclusions can be drawn concerning the anatomic site of the lesion. The results of the nonmetric multidimensional scaling show that patients can be represented in a two-dimensional space. From the correlation coefficients for the limitations of the ROM of the shoulder joint and the correlation coefficients with the presence/absence of pain during passive movements the first dimension can be interpreted as an indication of the severity of problems related to the shoulder joint. The second dimension can be regarded as an indication of the severity of problems related to the cervical spine (neck complaints). For the dimension of severity of neck complaints, however, the correlation coefficients with the presence/absence of pain are higher than those for the limitation of the ROM.

Each of the dimensions holds that the amount of limitations in the range of motions corresponds with the amount

of pain the patients experience. Patients exhibiting less restriction also indicate less pain. This would indicate that the physical examination of patients with shoulder pain can be simplified by averaging the amount of restriction of the motions of the shoulder and the amount of restriction of the motion of the neck.

The nonmetric multidimensional scaling showed that patients are more or less evenly distributed in the two-dimensional space, which means that on first sight there are no easily distinguishable groups of patients. This result is very different from analyzing dissimilarities between patients by means of hierarchical cluster analysis as was done by de Jongh [9] and Winters et al. [10]. In hierarchical cluster analysis the goal is to find disjunctive clusters of patients in such a way that patients belonging to one cluster are similar, and patients belonging to different clusters are dissimilar. In nonmetric multidimensional scaling patients are characterized by scores on continuous scales, which constitute the axes of the space, in which the patients are represented.

Although interobserver agreement on symptoms and signs of the physical examination of the shoulder joint is only very moderate [16–20], this study shows that for

Table 2

Pearson correlation between variables and dimensions for each observer<sup>a</sup>

Observer	A		B	
	1	2	1	2
<b>Examination of the cervical spine</b>				
<i>Restricted range of motion</i>				
Flexion	0.09	0.31	0.06	<b>0.49</b>
Extension	0.30	0.29	<b>0.48</b>	0.19
Rotation to affected side	0.24	0.26	<b>0.40</b>	0.39
Rotation to contralateral side	0.15	0.35	<b>0.42</b>	0.30
Lateroflexion to affected side	0.34	0.31	0.33	0.17
Lateroflexion to contralateral side	0.32	<b>0.41</b>	0.38	0.17
<i>Presence of neck pain</i>				
Flexion	0.23	<b>0.53</b>	0.21	<b>0.62</b>
Extension	0.39	0.37	<b>0.48</b>	<b>0.41</b>
Rotation to affected side	<b>0.41</b>	<b>0.56</b>	<b>0.44</b>	<b>0.63</b>
Rotation to contralateral side	0.31	<b>0.64</b>	0.34	<b>0.58</b>
Lateroflexion to affected side	0.39	<b>0.55</b>	0.39	<b>0.54</b>
Lateroflexion to contralateral side	0.38	<b>0.61</b>	<b>0.43</b>	<b>0.49</b>
<b>Active and passive movements of the shoulder joint</b>				
<i>Restricted range of motion</i>				
Elevation shoulder girdle	0.30	−0.04	0.02	0.19
Active abduction	<b>0.66</b>	−0.28	<b>0.70</b>	−0.18
Passive abduction	<b>0.73</b>	−0.33	<b>0.77</b>	−0.23
Passive glenohumeral abduction	<b>0.54</b>	−0.38	<b>0.59</b>	<b>−0.48</b>
Passive external rotation	<b>0.59</b>	<b>−0.42</b>	<b>0.55</b>	<b>−0.44</b>
Passive internal rotation	<b>0.63</b>	−0.37	<b>0.54</b>	−0.37
Passive horizontal adduction	<b>0.61</b>	−0.29	<b>0.57</b>	−0.11
<i>Presence of pain</i>				
Elevation shoulder girdle	<b>0.41</b>	0.18	0.33	0.06
Active abduction	<b>0.49</b>	−0.07	<b>0.41</b>	−0.20
Passive abduction	<b>0.68</b>	−0.03	<b>0.68</b>	0.05
Passive glenohumeral abduction	<b>0.56</b>	0.16	<b>0.51</b>	0.05
Passive external rotation	<b>0.66</b>	−0.09	<b>0.53</b>	−0.27
Passive internal rotation	<b>0.47</b>	−0.03	<b>0.51</b>	−0.12
Passive horizontal adduction	<b>0.56</b>	−0.13	<b>0.43</b>	−0.00
<i>Presence of painful arc</i>				
Presence of painful arc	−0.18	0.03	−0.12	−0.28
<i>Presence of abnormal scapulohumeral rhythm</i>				
Presence of abnormal scapulohumeral rhythm	<b>0.59</b>	−0.19	<b>0.40</b>	−0.29
Total SDQ score	<b>0.47</b>	0.13	<b>0.45</b>	0.17

<sup>a</sup> Correlation coefficients >0.40 are printed in bold.

both observers the same structure (two dimensions) emerged for patients with shoulder problems. Interobserver reliability on the two dimensions is indeed very good ( $r = 0.84$  for the severity of shoulder complaints) to acceptable ( $r = 0.69$  for the severity of neck complaints). This indicates that patients are ordered in about the same way on the dimensions by the two observers.

Another interesting aspect of the results of this study is that patients referred to a orthopedic practice or a clinic for rheumatology and rehabilitation did not differ from patients in general practice with respect to the severity of their complaints. The only difference was that the patients that consulted their general practitioner had more acute shoulder problems.

The lack of substantial correlations between the severity of pain that patients experience as assessed with the Visual Analogue Scale and the two dimensions illustrates that global measurements of pain are not very helpful in the

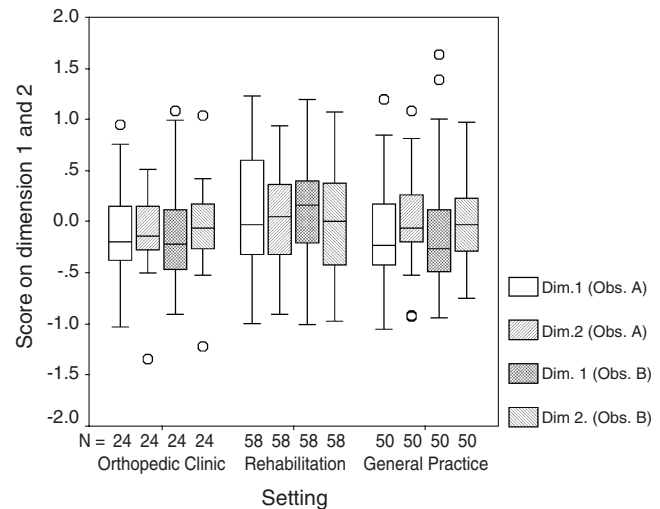


Fig. 2. Differences between settings in severity of shoulder complaints (Dim. 1), and severity of neck complaints (Dim. 2).

classification of patients with shoulder complaints. The substantial correlation of the Shoulder Disability Questionnaire [22] with the first dimension (severity of shoulder complaints) and the low correlation of this scale with the second dimension (severity of neck complaints) shows that a measurement in which in the phrasing of the items explicitly is referred to pain in the shoulder has a better discriminating ability. However, averaging the amount of restrictions in the motions will result in an even higher discrimination between patients.

From the review of Green et al. [28] and the study of Winters et al. [29], one can conclude that, in general practice, only two or three effective treatment options are available for patients consulting the general practitioner with shoulder complaints: treatment with a NSAID, manipulative therapy, and injection therapy. For the choice of which patients will benefit from each form of therapy the classification of patients in a small number of groups will be sufficient. The results of the nonmetric multidimensional scaling set the framework in which these groups of patients can be formed by choosing suitable cutoff point on the dimensions. Further

Table 3

Relationship between clinical characteristics and dimensions from nonmetric multidimensional scaling (Spearman correlation coefficients)

	Dimension 1 (severity of shoulder complaints)		Dimension 2 (severity of neck complaints)	
	Observer A	Observer B	Observer A	Observer B
Age	0.24*	0.34*	0.03	0.01
Duration of complaints	−0.04	−0.03	0.15	0.11
Pain during the day	0.29*	0.19*	0.21*	0.12
Pain at night	0.34*	0.22*	0.26*	0.13

\*  $P < .05$ .

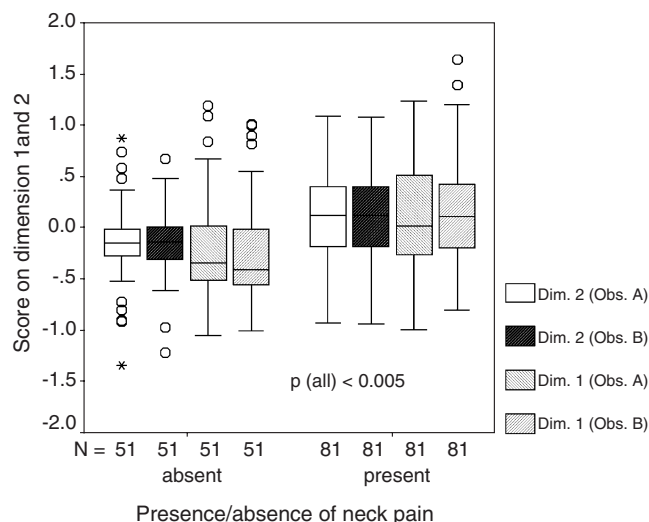


Fig. 3. Differences in shoulder complaints and neck complaint for patients reporting neck pain and those who do not report neck pain in history taking.

research will be needed to explore this possibility especially with regard to the distinction between patients eligible for injection therapy.

## 5. Conclusion

Patients consulting their general practitioner with shoulder complaints can be sufficiently reliable classified in two dimensions, indicating the severity of shoulder complaints or the severity of neck complaints. Given the limited number of effective therapies that exist today, the question remains whether a more refined diagnostic system is necessary.

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